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SHORTER ARTICLES AND DISCUSSION.

SIAMESE, AN ALBINISTIC COLOR VARIATION IN CATS

COMPARATIVE studies of color inheritance in mammals have shown that pigment production throughout the group is due to similar processes and to genes probably homologous. These studies have shown, for example, that the pink-eyed albino condition seen in white rabbits, white rats, white mice and white guinea-pigs behaves in all cases as a simple recessive in crosses. It is probably due to variation in the same (*i. e.*, in an homologous) genetic locus in all these rodents. In its usual form albinism consists in a complete absence of pigmentation from the ectoderm of the embryo and from all derivatives of that germ-layer in the adult animal. This includes, not only the hair, but also the retina and iris of the eye. Such is the condition seen in the white mouse, the white rat, and the "Polish" or "Russian" rabbit. But this same locus may apparently undergo a different change which, while it behaves as the perfect allelomorph of the pure white albino variation, differs from it in that it allows a certain amount of pigment to be produced, more particularly in the retina of the eye and in the hair at the extremities of the body (nose, ears, tail and feet). At times a small amount of pigment is formed elsewhere throughout the coat. This condition is best known in the "Himalayan" rabbit. Clear white albinism of the Polish rabbit is an allelomorph of Himalayan albinism. In the guinea-pig only the Himalayan type of albinism is known; in rats and mice, only the Polish type is known.

In the guinea-pig, Wright has demonstrated the existence of two other albino allelomorphs, which apparently are distinct mutations of the same genetic locus. These are found in the red-eyed and in the dilute varieties described by him. Among rats Whiting and King have demonstrated the existence of a variety comparable with the dilute varieties of guinea-pigs and which they call "ruby-eyed." It behaves as an allelomorph of ordinary albinism in crosses.

White spotting of colored animals, sometimes called "partial albinism," is an entirely different variation, due to variation in a different locus. True albinism and spotting may by suitable crosses be made to coexist in the same individual. In this way

I have frequently produced *spotted* Himalayan rabbits, which would show particular types of white spotting, as Dutch or English, on the feebly pigmented Himalayan background (as has also Punnett), and Wright has produced whole series of varieties of spotted red-eyed and spotted dilute guinea-pigs.

Among certain rodents pink-eyed varieties occur which are due to variation in a genetic locus wholly distinct from that which is responsible for albinism. Such are the well-known pink-eyed varieties of mice having colored coats. Here the retina and the fur alike have a greatly reduced amount of black and brown pigmentation as compared with normal individuals, though yellow is unaffected. Pink-eyed rats and pink-eyed guinea-pigs are similar in appearance and in genetic behavior to pink-eyed mice. When crossed with the albino variety of the same species, they produce fully colored offspring as regards both eye and coat. The gene for pink-eye is thus seen to be complementary to the gene for albinism, with which it is known to be "linked" in rats and mice. Whether the two are also "linked" in guinea-pigs has not yet been ascertained.

Among mammals other than rodents albino and pink-eyed varieties are not certainly known to occur, though white-spotted and black-eyed white varieties are common. It is thus an open question whether the same genetic loci are found among them as among rodents. Bateson has pointed out similarities between a color variety of cat, the so-called Siamese, and the Himalayan variety of rabbit. Both are born white or nearly white and later become more heavily pigmented. I may add (2) that both are inherited as recessives and (3) that in both varieties yellow pigment is largely or wholly suppressed, which is characteristic of the albino variation, but not of the pink-eye variation of rodents.

Wright has suggested that blondism among human beings (which when extreme in character is commonly known as albinism) is similar in nature to the albinism of rodents, being a graded series of allelomorphs similar to the series which he has described in the guinea-pig.

It thus appears probable that the same genetic locus, which occurs in rodents and which has been called the "color factor," occurs also in other mammals, including man.

The case of the Siamese cat has seemed to me for some years deserving of more careful study. Lacking opportunity for such study myself, I sent out an inquiry several years ago through

the pet-stock journals for information about Siamese cat crosses. A single reply has just come to hand, but from an authoritative source. A doctor, who prefers to remain anonymous, resident in an extensive institution in England and a fancier of Siamese cats, has employed his leisure, and the unusual opportunities afforded by his position, in studying the genetic behavior of Siamese cats in crosses with other varieties. He regards as characteristics of the Siamese breed a peculiar quality of voice and "cross-eyes," which characters often are seen in first generation crosses and so would seem to be inclined to dominance. But the distinctive Siamese color, he states, is never seen in F_1 individuals, "although quite a number show a mid-way color. At a glance you would say they were black, but on more careful examination you see they are near the color of the Siamese ears, seal brown. Most first crosses in my experience are black or seal, but some tortoise shell, or tortoise shell and white, or black and white." These statements indicate the usual behavior of yellow and of white-spotting in cat crosses. (See Whiting, 1918.) The Siamese color is evidently an independent character incompletely recessive in F_1 . The doctor continues his account with a brief statement concerning a back cross of F_1 with pure Siamese. "I have a first cross female, black seal color, marked cross eyes, Siamese voice. She has been twice mated with a pure Siamese male. In her first litter she had two pure Siamese, perfect Siamese color. Unfortunately both died of distemper when about three months old. Her second mating resulted in one pure Siamese which is still alive. It is about five months old and is perfect in all Siamese points and fit to win [at shows]." Presumably the same sort of back-cross matings as these would produce also kittens similar to the F_1 mother in color character, although no mention is made of them in these notes. The information given suffices to show the segregation of Siamese color as a recessive character in generations later than F_1 . The doctor confirms the observation of others as to the deficient pigmentation of the eye, a point of resemblance with allelomorphs of true albinism, as seen, for example, in red-eyed guinea-pigs (Castle and Wright), and in ruby-eyed rats (Whiting). He says: "The reflex which the Siamese cat shows in the dark is worth notice. It looks blood red and must be due to absence of pigment in the retina." A further point of resemblance with albinism is its distinctness from dilution as seen in "blue" varieties. The doctor speaks of having produced

four Siamese which are "blue-pointed," presumably as a result of crosses with maltese, which are blue pigmented. An exactly similar combination I have recently secured in crossing rabbits, obtaining Himalayans with blue points in F_2 from a cross between ordinary black-pointed Himalayans and a self-colored rabbit which carried blue as a recessive character.

To summarize, we have the following indications that Siamese coloration in cats is a form of true albinism similar to that of the Himalayan rabbit, and still more closely resembling the ruby-eyed rat and the red-eyed guinea-pig, all of which species possess also more typical forms of albinism, but which are allelomorphs of those mentioned.

(1) Siamese coloration in cats is attended by a deficiency in amount of pigmentation in both coat and eye. (2) Yellow pigment is more affected than black or brown pigment. (3) The pigmentation is less at birth than at a later period. (4) The character is recessive in heredity. (5) It is distinct from "blue" dilution since it can be combined with it by suitable crosses.

Siamese in cats as far as reported occurs only in a non-agouti form, as does Himalayan in rabbits bred for exhibition. But by a cross with agouti rabbits, Himalayan rabbits are obtained in F_2 which have agouti points. As this makes the contrast of points with body less strong, fanciers' standards do not recognize the combination. Nevertheless the experiment shows agouti to be due to a genetic factor distinct from Himalayan. If Siamese in cats is also distinct from agouti, it may be expected that a cross of Siamese with tabby would produce Siamese tabbies in F_2 , though the combination would probably not be pleasing to the fancier.

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